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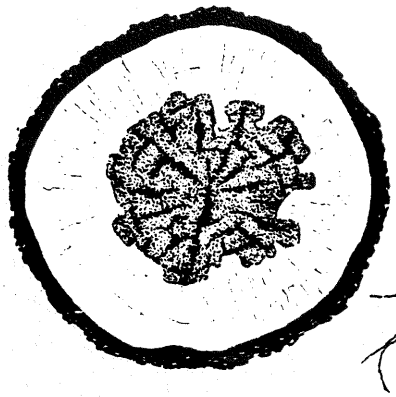
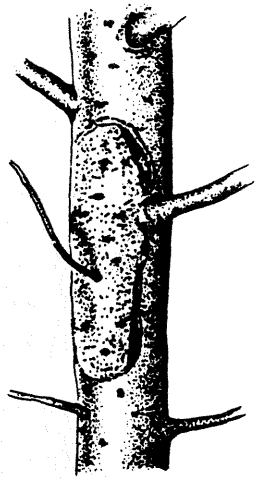
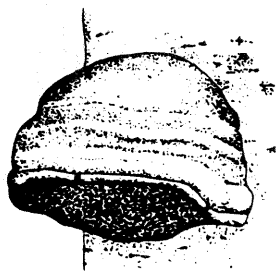
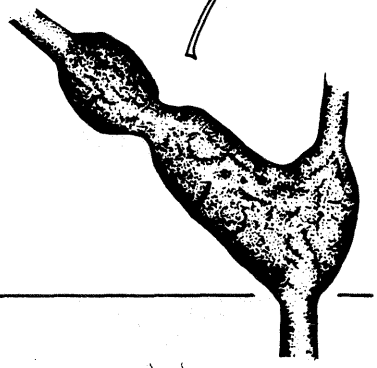
INTRODUCTION TO FOREST DISEASES

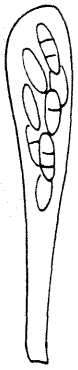
in Alaska



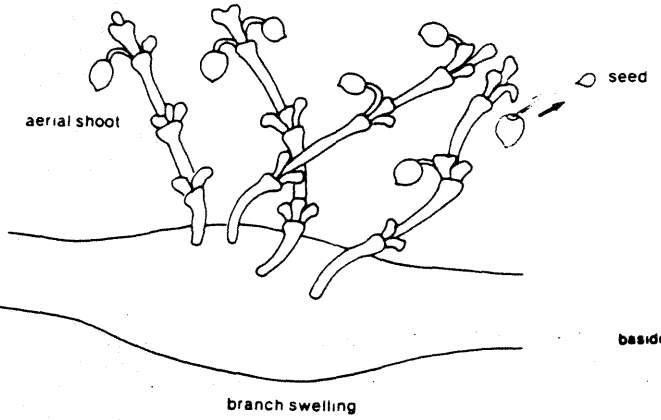








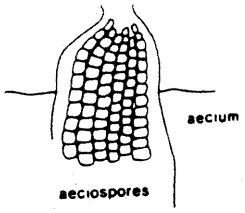
ascus



aerial shoot

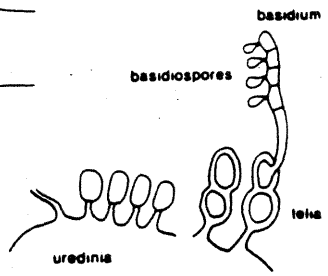
seed

branch swelling



aecium

aeciospores



basidium

basidiospores

teliа

uredinia

Dwarf mistletoe

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FOREST DISEASES IN ALASKA
Soldotna, August 1985

Plant disease-def.- Any impairment of normal growth, reproduction, or structure to plants

Pathogens- Organisms that cause plant disease

Causes: Abiotic-No organism
-fire, wind, freezing, mechanical injury, root compaction - esp. for old spruce
Biotic- Organism--fungi, bacteria, viruses, higher plants-dwarf mistletoe
animals- porcupines, bears -scar or eat stem cambium.

FUNGI
- most important pathogens to plants
- no photosynthesis
- hyphae- microscopic threadlike strands for feeding
- spores- microscopic, produced from fruiting bodies (mushrooms, conks, or microscopic structures)
- saprophytes- majority of fungi live on dead organic material, helping to recycle nutrients.
  parasites- others live on living plants as pathogens (destructive), mycorrhizae (benificial fungi in live roots)

Groups of pathogenic fungi:
OOMYCETES - water molds
- swimming spores
- root diseases, nursery and ornamental problems

ASCOMYCETES - sack fungi
- foliage, twig, canker, root diseases

BASIDIOMYCETES
- decays, rusts, root disease

RUSTS
- Orange, yellow, or brown pustules (dry), should see sporulation for rust disease
- live plants and parts only (obligate parasite)
- usually must grow on 2 hosts to complete life cycle.
- a primitive type of Basidiomycete (but no conk or mushroom)

- Spruce broom rust (Chrysomyxa arctostaphyli)
  - on spruce - screws up hormones, kill tops, decrease growth slightly
  - on Arctostaphylus, kinnikinik leaf spot
- control? do nothing, prune infection if in branch, remove tree, plant non spruce
- Spruce needle rust (Chysomyxa ledicola)
  - On spruce needles, no brooming
  - On Labrador tea plant- leaf spot

- Hemlock-blueberry rust (Pucciniastrum vaccinii)
  - On western hemlock needles
  - On blueberry leaves

- Western gall rust (Endocronartium harknessii)
  - on lodgepole pine
  - causes spherical galls
  - kills branches, tops, small trees
  - attacks most vigorously growing pines
  - attacks only pine, no alternate host

- Hardwood leaf rusts (Melampsora spp.)
  - e.g., Aspen, Willows, Roses, some fruit trees
  - See Ziller (Tree Rusts of Western Canada, color pictures) or Hepting (no pictures) for ID.

- Control?? most rusts do not kill plant, must have live tissue.
  - leave alone, plant non-sucseptible plant
  - prune out diseased branches, no need to burn or dispose
  - protectant sprays in spring or when sporulating see Ziller, 1974.

FOLIAGE AND TWIG DISEASES

- Fungi infect leaves (leaf or needle disease), or grow down twigs (twig blight)
- temporary epidemics appear if weather conditions (often cool and moist) favor fungal sporulation or infection OR if trees become stressed
- Twig blight of aspen (Venturia populina)
  fungus grows down twig.
  tiny black fruiting body
  prune, remove inoculum, wait-next year may not be problem

- Shoot blight of hemlock (Sirococcus strobilinus)
  - fungal problem in young growth hemlock in southeast Alaska
  - kills shoots, tiny black fruiting body on killed stem

- Spruce needle cast (Lophodermium filiformae and L. picea)
  - fungus attacks 2yr and older needles
  - black fruit bodies on killed needles
  - triggered by wet spring conditions which favor sporulation and needle infection
  - may reduce growth, rarely kills trees unless several consecutive years of infection

Cedar blight blight (Didymascella thujina)
small dark cushion-shaped fruiting body on cedar foliage
falls out leaving hole in foliage
only on western redcedar.
control- do nothing, doesn't kill, weather triggered, fungi rarely attack all needle age classes on conifers

CANKERS

Dead areas on stems, annual-callus (heal over) or perennial (enlarge each year).
sometimes kill plant by girdling
look like wound, look for fruit bodies
mostly caused by Ascomycetes, some caused by Basidiomycetes with wood decay

Examples of canker diseases:

Cryptosphaeria canker (Cryptosphaeria populina)
on aspen
infects through bark

Cytospora canker (Cytospora chrysosperma)
look for small fruiting bodies to differentiate aspen cankers

Sooty bark disease (Cenangium singulare
most damaging of aspen cankers

Ceratocystis canker (Ceratocystis fimbriata
perennial target shaped canker
relative of fungus causing dutch elm disease

Cankers of conifers
less is known of these
often confused with mechanical and animal injury
some, e.g., Xenomeris can be damaging
see Funk's book on stem diseases

Diamond willow--actually a canker disease probable cause is a Valsa sp.

ROOT DISEASES

Symptoms-whole crown has symptoms, not one branch
fast death--all leaves or needles die at once
slow death--all leaves or needles are yellow, small or die

Causes--many different causal agents have the same symptoms
fungi (Ascomycetes, Basidiomycetes, Oomycetes)
Nematodes, Bacteria, Insects
soil nutrient deficiency, toxicity

Symptoms:
root disease fungi- look for lesion at root color, inspect fine roots
root disease bacteria- large swollen galls -- Agrobacterium crown gall
nematodes- microscopic worms
insect feeders eg., root weevils

Armillaria sp. (Armillaria root disease or Honey mushroom)
common saprophyte of woody debri on almost any woody plant species
also heartrot of conifers
causes white rot
fruiting body is a yellow-brown mushroom, but is uncommon
can colonize large pieces of dead wood (eg root system), then attack adjacent live tree
can be a problem in regeneration after logging
spreads by rhizomorphs (black shoestring-like structures)
kills by girdling cambium with white mycelial fan

Fomes (Heterobasidion) annosum (Annosus root disease)

important heartrot (confined to root and butt) especially w. hemlock
causes white rot
conk rarely found, looks much like F. pinicola
can attack young-growth hemlock and spruce
infects through 1)wounds, 2)by invading thinning stumps through freshly cut surface, grows down dead root system, infects adjacent live tree by growing across root contact, can then kill the live tree.
Control losses by early rotation, reducing wounding and/or thinning operations, treating freshly cut thinning stumps with antagonistic fungi

Abiotic cause
symptoms very similar to those of pathogen-caused diseases
off site planting - plants not adapted to soil or climate
eg. lots of ornamental plants in Alaska
soil compaction, soil piling on spruces near home construction e.g., old spruces
poor drainage--pooling water, clay soil, black roots
under/over fertilization or watering
Hard to ID caues symptoms very similar with diff. causes
-look at soil--compacted, soil piling
-recent freezing?
-can host tolerate climate of Alaska??
-ask questions about recent fertilization, chemical applications
-use ref. books to see what is common for that host

Control--try & determine cause
--replace plant if dead
--improve soil at that time
--fumigate soil if pathogen
--replace with plant tolerant of problem

ABIOTIC PROBLEMS

- Air pollution
  SO_2 Pulp mill near Sitka
  all tree species affected

- Ammonia gas spill in shipwreck

- Frost cracks- often have associated decay

- Winter desiccation- warm winds in winter when ground cold or frozen and trees can't replace transpired water OR foliage looses cold hardiness due to warming up, then return to cold weather causes freezing injury.

ANIMAL DAMAGE

- Porcupines
  girdle stems of many tree species
  girdling causes death of tissues above chewing line
- Sapsucker damage
- Brown bears
  basal scars on Alaska-cedar in southeast AK
- Black bears
  basal scars on white and sitka spruce on Kenai and Glacier Bay

DISEASES OF UNKNOWN CAUSE

- Flutting of western hemlock
  deep invaginations along the bole
  bark occurs deep in the wood, reducing value for sawlogs or pulping
  probably genetically controlled, but for what advantage? for wind resistance?

- Yellowing of branches of Mt. hemlock
  cause unknown
  rarely, if ever, kills trees

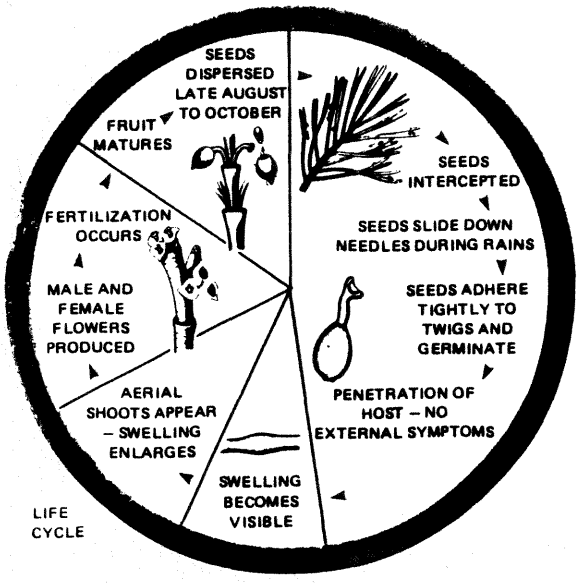
- Alaska-cedar decline
  extensive mortality throughout southeast Alaska
  casue unknown
  symptomms suggest root pathogen
  many fungi isolated, but non are strong pathogens
  problem began around 1880 and has never spread
  control-salvage; Alaska-cedar is extremely decay resistant, trees dead for 80-100 yrs still stand are probably have some commercial value

- Burls- hormonal imbalance
  in western hemlock- often caused by dwarf mistletoe
  in spruce- common- cause unknown

DWARF MISTLETOE

- caused by Arceuthobium tsugense
  a small yellowish seed-bearing plant
  it does not photosynthesize, only lives as parasite
- most important disease of western hemlock
- rare on sitka spruce, mt. hemlock; only in southeat AK
- Life cycle:
  - seeds forceably discharged (up to 50') from female plants
  - seeds stick on hemlock foliage or twigs, overwinter
  - in spring, seeds germinate, penetrate thin bark
  - develope perennial root system in hemlock twigs
  - mistletoe shoots emerge, either male or female flowers
  - pollination, probably by insects
  - female flowers produce seeds

DWARF MISTLETOE (*Arceuthobium*)


SEEDS DISPERSED LATE AUGUST TO OCTOBER
FRUIT MATURES
SEEDS INTERCEPTED
FERTILIZATION OCCURS
SEEDS SLIDE DOWN NEEDLES DURING RAINS
MALE AND FEMALE FLOWERS PRODUCED
SEEDS ADHERE TIGHTLY TO TWIGS AND GERMINATE
AERIAL SHOOTS APPEAR – SWELLING ENLARGES
PENETRATION OF HOST – NO EXTERNAL SYMPTOMS
SWELLING BECOMES VISIBLE
LIFE CYCLE

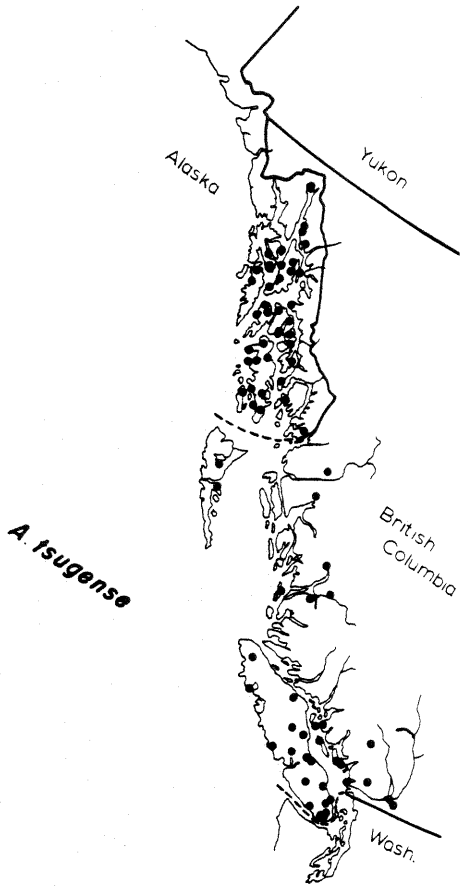
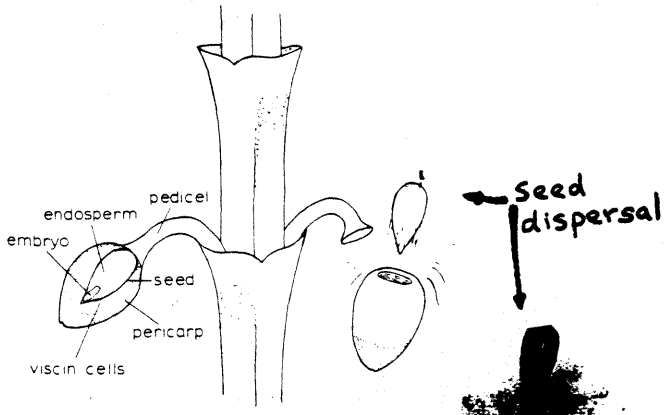


Figure 77.—Distribution of *Arceuthobium tsugense* in British Columbia and Alaska (based on collections and reports).



Infected branch--
Witche's broom

- Dwarf Mistletoe Control:
  - clear cutting controls mistletoe in old-growth hemlock
  - how to keep it out of young-growth hemlock stands?
  - infected hemlocks growing above young hemlock stand is a worst case situation (infected residuals left after clear-cutting are common)
  - 1) kill (by girdling or felling) infected residual hemlocks
  - 2) do not have infected old-growth hemlocks on clear cutting boundaries with

GREENHOUSE AND NURSERY DISEASES
-- warm and humid
- powdery mildew--white mold on live leaves --eg. roses, melon leaves
  usually won't kill, but unsightly
  spray protectant fungicides
- Botrytis- kill tops, branches, whole plants
  - must have humid wet conditions, usually with plants packed densely
  - space plants, control mist watering, spray fungicides remove disease material--it spreads by spores from diseased material

DECAYS AND HAZARD TREES

- Wood decay is often the largest loss of wood volume in old-growth forests
- Losses are much less in young growth forests
- Wood decay is usually beneficial; saprophytes decompose dead parts of trees to release nutrients to live trees
- Wood decay is a problem when it occurs on live trees; either reducing wood volume or making trees hazardous in recreation areas.
- Some fungi are highly specialized, only occurring as heartrot fungi in live trees (e.g., Fomes pini and Fomes igniarius)
- Other fungi are saprophytes, only occur on live trees if large wounds allow entry.
- 2 types of wood decay:
  Brown rot- only cellulose is decomposed (eg, Fomes pinicola)
  White rot- cellulose and lignin are decomposed (eg, Fomes igniarius)

Examples of important Alaskan decay fungi:

Fomes (Fomitopsis) pinicola (Redbelt fungus)
most common large conk on conifers in Alaska
usually on slash
on live trees, wounded, sometimes unwounded
conk is large, grey top, white bottom, pores circular, red band on upper edge (sometimes), white inside
causes brown cubical rot
causes 73% of cull in Sitka spruce

Fomes (Phellinus) pini (Red ring rot)
heartrot of living conifers, not on slash
usually on unwounded trees
common on mountain and western hemlocks
commonly seen growing below branch stub
conk is shelf-shaped, upper surface is brown, lower brown, rusty-brown inside, pores are angular (sometimes circular)

Ganoderma applantaum (Artist's conk)
on conifers - usually on shash, logs
on hardwoods- heartrot of living trees and slash
causes white rot
conk- perennial sometimes quite large, shelf-shaped, upper surface tan and "dusty" covered with spores, bottom white which turns brown by touching or scoring, inside dark brown

Polyporus sulphureus (Chicken of the woods)
on conifer logs, slash, also as heartwood decay of living trees
sometimes on hardwoods
causes brown rot
common on hemlocks, especially if scarred
conk is yellow on top, yellow on bottom, large annual, watery
conk turns white and soggy when dead
conk is edible; careful, don't eat fungi unless certain of ID

Polyporus (Phaeolus) schweinitzii
root and butt rot of conifers
causes brown rot
conk at base of tree or on ground near tree
conk large annual, brown (with greenish tinge) fleshy when fresh
conk dark brown and dry-brittle when dead
conk can be used as brown die
trees in recreation areas with this fungus can be very hazardous

Fomes fomentarius (Tinder fungus)
on birch
conk is perennial, hoof-shaped, white to grey on top, brown on bottom, and brown inside
causes white rot
both a slash decomposer and a heartrot

Fomes (Laricifomes) officinalis (Quinine conk)
causes brown rot
one conk on a tree indicates tree is entire cull
conk is white on top, bottom and inside
conk is large, sometimes huge

Polypous borealis
trunk rot, usually low on bole
conk is small, white, shelving
usually on spruce, less on hemlock

Fomes (Phellinus) robustus
- heartrot of western hemlock
- can invade and kill sapwood and cambium on side of infected tree
- conk is flat or bulging never hoof of shelf-shaped
- conk common under branch stub

Armillaria sp. (Armillaria root disease or Honey mushroom)
- common saprophyte of woody debri on almost any woody plant species
- also heartrot of conifers
- causes white rot
- fruiting body is a yellow-brown mushroom, but is uncommon
- can colonize large pieces of dead wood (eg root system), then attack adjacent live tree
- can be a problem in regeneration after logging
- spreads by rhizomorphs (black shoestring-like structures)
- kills by girdling cambium with white mycelial fan

Fomes (Heterobasidion) annosum (Annosus root disease)
- important heartrot (confined to root and butt) especially w. hemlock
- causes white rot
- conk rarely found, looks much like F. pinicola
- can attack young-growth hemlock and spruce
- infects through 1)wounds, 2)by invading thinning stumps through freshly cut surface, grows down dead root system, infects adjacent live tree by growing across root contact, can then kill the live tree.
- Control losses by early rotation, reducing wounding and/or thinning operations, treating freshly cut thinning stumps with antagonistic fungi

Fomes (Phellinus) igniarius (False tinder fungus)
- major heartrot of hardwoods
- very close relative Fomes (Phellinus) tremulae is a serious heartrot of Aspen
- cause white rot of heartwood of living trees, not on slash
- conk is perennial, hoof-shaped black on top, brown on bottom, rusty brown inside
- control- remove trees with conks from recreation sites, use lower rotation age in commercial stands

Hericium sp. (Coral fungus)
- slash decomposer and heartrotter of trees with large wounds
- causes brown rot
- fruiting body is large, whitish, watery and resembles coral

Ganoderma oregonense (lacquer conk)
- log and stump decomperser
- causes brown rot
- conk is large annual, black and shiny (varnished appearance) on top, white on bottom, white inside, with or without large stalk

Echinodontium tinctorum (Indian paint fungus)
heartrot of mountain hemlock
caues brown rot
so far only found in the Haines and Skagway area
conk is large hoof-shaped, brick red inside, dark on top, and bottom is composed of course grey teeth instead of pores

Pholiota sp.
heartrot of spruce
causes brown rot
fruiting body is a yellowish white mushroom, formed in abundance near the base of the affected tree

PATHOLOGICAL ROTATION

When decay fungi destroy more wood per year than is being produced, there is a net loss of wood produced for that stand.
this condition is called pathological rotation and suggests that the stand be cut and regenerated to prevent further losses.
the stand age for pathological rotation varies considerable for species and within species in different locations

Here are a few examples:

Sitka spruce, Queen Charlotte Is.	250-300 yrs
White spruce, Maritime, Canada	apprx 160 yrs
Western hemlock, British Columbia	225-275 yrs
Aspen, Minnesota	40-50 yrs
Aspen, Northern Ontario	120 yrs

ADDITIONAL INFORMATION:

Funk, A. 1981. Parasitic Microfungi of western trees. Can. For. Serv. Pacific Forest Research Centre. BC-X-222. 190p.
Funk, A. 1985. Foliar fungi of western trees. Can. For. Serv. Pacific Forest Research Centre. BC-X-265. 159p.
Hepting, G.H. 1971. Diseases of forest and shade trees of the United States. USDA Ag. Handbook No. 386. 658p.
Holsten, E.H., R.A. Werner, T.H. Laurent. 1980. Insects and diseases of Alaskan forests. USDA For. Serv. Alaska Region. Report No. 75 187p.
Ziller, W.G. 1974. The tree rusts of western Canada. Can. For. Serv. Publ. No. 1329. 272p.

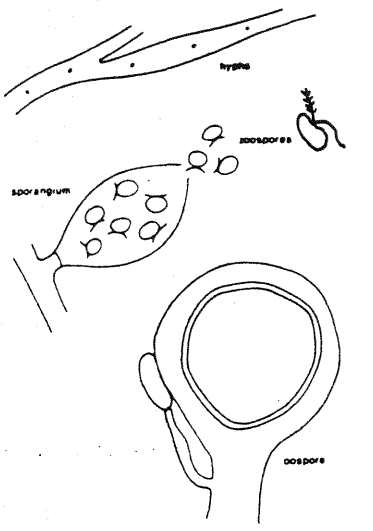


Fig. 1. Characteristics of the OOMYCETES

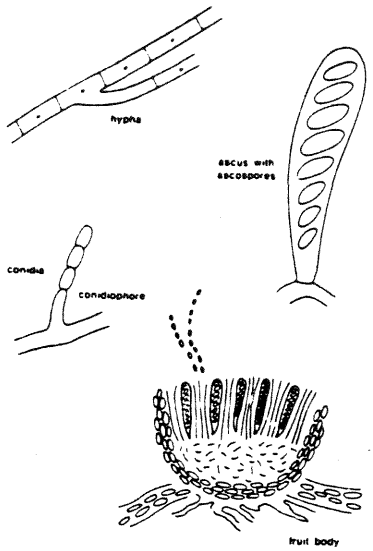


Fig. 2. Characteristics of the Ascomycetes

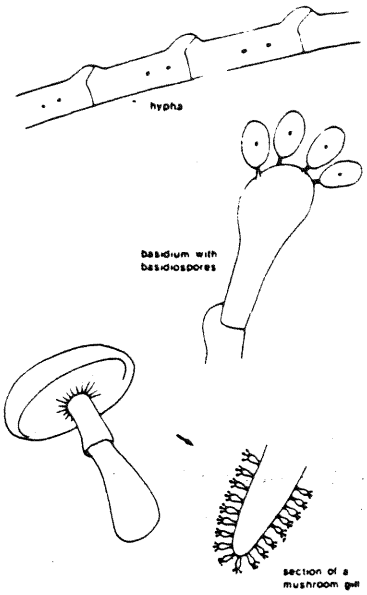


Fig. 4. Characteristics of the Basidiomycetes.

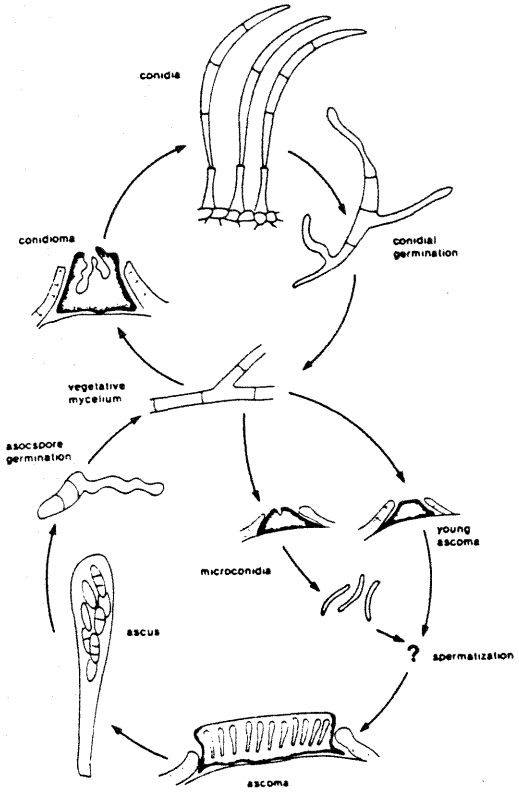


Fig. 3. Life cycle of an Ascomycete, *Dermea pseudotsugae*.

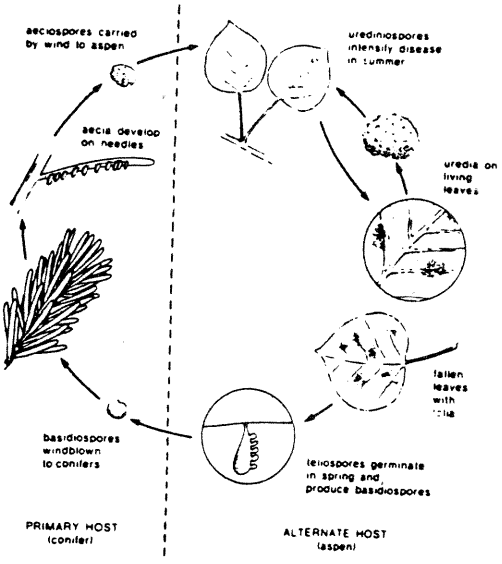

aeciospores carried by wind to aspen
urediniospores intensify disease in summer
aecia develop on needles
uredia on living leaves
fallen leaves with telia
basidiospores windblown to conifers
teliospores germinate in spring and produce basidiospores
PRIMARY HOST (conifer)
ALTERNATE HOST (aspen)

Fig. 6. Life Cycle of a Rust, *Melampsora medusae*.

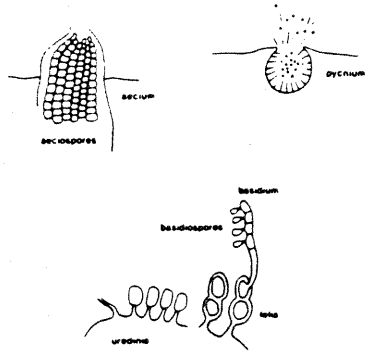


Fig. 5. Characteristics of the Uredinales (Rusts).

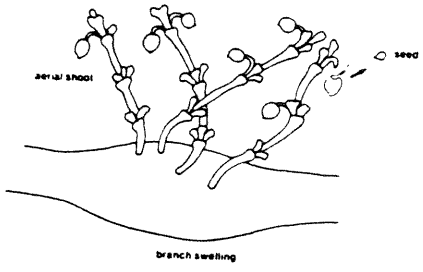


Fig. 7. Dwarf mistletoe aerial shoots in branch swelling and explosive fruit releasing seed.